US LHC Accelerator Project	Baseline Change Request
BCR Number	36
WBS	1.4.1 – BNL LHC Accelerator Physics 1.4.2 – FNAL LHC Accelerator Physics
Title	Reduction in FY2002 Accelerator Physics Effort
Change Control Level	2
Originator	J. Strait
Date	3 October 2001

Description of change

This baseline change reduces the accelerator physics effort at BNL and FNAL in FY2002 to the level that ensures that only work that is essential to the success of the US LHC Accelerator Project is retained. The work that is retained is that which directly supports the design and construction of the US-provided hardware, plus a small amount of effort specifically requested by CERN. A corresponding reduction in accelerator physics work at LBL was taken in BCR 29.

Details of this change are given in a memo which was presented to the Interlab Steering Committee and discussed at its meeting on 20 September, 2001. The Steering Committee recommended implementation of the changes proposed in that memo, and this BCR is that implementation. A copy of the memo is an Appendix to this BCR.

Reason for change

To preserve adequate contingency for the remainder of the project, it is necessary to limit the work to that which is essential and remove work which, however desirable, is not essential.

Impact on other sub-systems

None

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Impact on cost

The change in the baseline budget for BNL and FNAL accelerator physics in FY2002 is summarized in the table below. The cost of the FNAL AP program is slightly different from that in the memo in Appendix 1 due to the different ratio of research associates to staff physicists.

Current Baseline							
		Work		Cost		G&A	Total
WBS	Task	(hours)	(months)	FY01$	FY02$	FY02$	FY02$
BNL (BCR 25)							
1.4.1.1.5	Accelerator Scientist FY02	3,355	23.0	239,066	245,523	77,816	323,339
FNAL (BCR 30)							
1.4.2.7	Physicist FY02	1,225	8.4	80,997	83,185	25,573	108,758
1.4.2.8	Research Associate FY02	3,500	24.0	121,170	124,443	38,256	162,699
	Total FNAL	4,725	32.4	202,167	207,627	63,829	271,457
New Baseline							
		Work		Cost		G&A	Total
WBS	Task	(hours)	(months)	FY01$	FY02$	FY02$	FY02$
BNL							
1.4.1.1.5	Accelerator Scientist FY02	1,750	12.0	124,688	128,055	40,586	168,641
FNAL							
1.4.2.7	Physicist FY02	1,021	7.0	67,498	69,321	21,311	90,631
1.4.2.8	Research Associate FY02	1,896	13.0	65,634	67,407	20,722	88,129
	Total FNAL	2,917	20.0	133,131	136,727	42,033	178,760
Change							
		Work		Cost		G&A	Total
WBS	Task	(hours)	(months)	FY01$	FY02$	FY02$	FY02$
BNL							
1.4.1.1.5	Accelerator Scientist FY02	-1,605.31	-11.0	-114,378	-117,468	-37,230	-154,698
FNAL							
1.4.2.7	Physicist FY02	-204	-1.4	-13,500	-13,864	-4,262	-18,126
1.4.2.8	Research Associate FY02	-1,604	-11.0	-55,536	-57,036	-17,534	-74,570
	Total FNAL	-1,808	-12.4	-69,036	-70,900	-21,796	-92,697
	Total Change	-3,414	-23.4	-183,414	-188,368	-59,027	-247,395

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Impact on schedule

None

Other impacts (ES&H, etc.)

None

Change Control Board recommendation (if required)

Approvals

WBS Level 3 Manager	Date
Laboratory Project Manager	Date
Change Control Board Chair	3 Oct 01 Date
US LHC Accelerator Project Manager	3 Oct 01 Date
DOE LHC Project Manager	5 Oct 01 Date
Director, DOE Division of High Energy Physics	Date

BCR 32 Appendix
Memo on Reduced Accelerator Physics Effort

14 Sep 2001

To: US LHC Accelerator Project Interlab Steering Committee
From: Jim Strait
Subj: Proposed reduction in US LHC AP effort in FY2002

To address the less than comfortable contingency position of the Project as of the time of the May Lehman Review, I initiated a review of the Accelerator Physics effort to ensure that the work done through the end of FY2002 is only that which is essential to the success of the Project, and that inessential work be removed from the Project work scope. At that point contingency was 16.9% of the estimated cost to go. As of the August status meeting, this had dropped to 14.6%, making the completion of this review even more important.

On May 10 I asked each of the laboratories to submit a plan for the period through the end of FY2002, which evaluates each piece of work as to how closely it is related to the design and construction of the hardware deliverables of the US LHC Project, to the design and construction of other equipment or systems for the LHC for which we are not directly responsible, or to planning for dealing with operational issues in the LHC. Copies of the plans submitted are attached. A video meeting was held on June 4, at which these plans were presented and discussed. This meeting was immediately followed by a meeting of the Interlab Steering Committee. An action item from the Steering Committee meeting was for me to complete my review and make a proposal for reductions in the AP effort, which would then be presented to the Committee for discussion. This memo is that proposal.

In the mean time, I discussed possible reductions in the US LHC AP program with Francesco Ruggiero and Oliver Brüning during a visit to CERN in late June. They specifically requested that certain pieces of work continue. These are 1) electron cloud effect calculations; 2) tracking studies, or documentation of studies already done, to address the robustness of the inner triplet correction system with respect to alignment errors and beta function errors; 4) better documentation of alignment tolerances; and 4) beam experiments at RHIC related to coherent beam-beam effects. In addition, they supported our continued work on inner triplet field quality and alignment issues and on energy deposition calculations.

Also in the mean time, LBL agreed to modest reductions in the FY 2002 AP effort relative to that in their plan presented to the June 4 video conference. This reduced program has been codified as their new baseline in BCR 29.

Table 1 summarizes the AP programs presented at the June 4 meeting, and shows the reductions in effort that I propose. The left half of the table shows the efforts for different activities at each lab as presented at the June 4 video conference. Below is shown the integrated FY2002 effort and cost (FY01$ without overheads) as given in the current baselines for each lab. Note that the proposed BNL effort exceeds modestly the baseline budget. The detailed effort levels at Fermilab were not included in the written submission, but are those presented by Tanaji at the June 4 meeting. The overall effort listed at the bottom of the Fermilab submission was in error, as it included effort that this year is being charged to the last of the infrastructure funds. The Fermilab baseline budget is less than BNL's for a greater effort due to the fact that it mostly supports post-docs.

BCR 32 Appendix
Memo on Reduced Accelerator Physics Effort

Table 1. Current baseline and proposed new AP plan for FY2002.

	As presented by labs for 4Jun01 video conference			JBS Proposed Modifications		
	Effort (FTE-months)			Effort (FTE-months)		
Activity	BNL	FNAL	LBNL	BNL	FNAL	LBNL
Total effort	27.6	32.4	10	12	20	6
Alignment	6	2		2	2	
Magnet acceptance	12	5		5	5	
IR Correction	2.4			2.4		
Design 2nd gen IR		5			0	
Sorting strategies		2			2	
Energy deposition		14.4			11	
IR 1/5		2.4			2	
LBL instr		1			0	
IR 2/8		8			6	
IR6		3			3	
Beam Beam		4			0	
Electron cloud effect			4			3
IR abs. and instr.	3.6		6	0		3
Beam experiments	2.4			1.4		
Organization	1.2			1.2		
		31				
FY02 current baseline	BCR 25	BCR ~~32~~	BCR29	Proposed Cost		
FTEs	1.9	2.7	0.5	1.0	1.7	0.5
FTE-months	23	32	6	12	20	6
FY01$	$239.1k	$202.2k	$79.4k	$124.7k	$124.8k	$79.4k
3-Lab total	$520.7k			$328.9k		

As noted above, the LBL baseline as of BCR 29 already includes reductions taken following the June 4 meeting.

My proposed reduced plan is shown on the right half of the table. I reduced the BNL effort on magnet acceptance and alignment related activities to be the same as the Fermilab program. Ten FTE-months between the two labs seems adequate to evaluate field quality for the roughly dozen dipoles at BNL and 1 or 2 quadrupole assemblies at FNAL that will be completed during FY2002. Since BNL has taken the lead on studying IR correction schemes, I have left the effort there at the proposed level. Effort on IR instrumentation at BNL and FNAL has been eliminated, since this is no longer part of the Project. The remaining effort at LBL should allow Bill to complete analysis of the beam test now under way and to participate with CERN in the decision as to what technology will be used for the luminosity monitor when it is implemented by us (as an LHC upgrade under the Commissioning and Operations budget) or by others. I reduced the effort for beam experiments at RHIC to a level that will allow support of the one experiment cited above on coherent beam-beam effects. This is, as I understand it, the one experiment related to LHC that would not be carried out anyway for the benefit of RHIC. I eliminated the design of 2nd generation IRs and the beam-beam calculations from the Fermilab program, both because these do not directly support the LHC construction project, and because I believe that this work will likely continue with or without LHC Project funding. I have also reduced modestly the budgeted effort on energy deposition

calculations for IRs, based on my estimation that the essential pieces of this work can be done with the reduced effort.

The total reduced effort and an estimate of the reduced cost is summarized at the bottom of the right half of Table 1. The cost has been estimated simply by scaling the baseline costs by the ratios of FTEs, without taking account of changes, if any, in the mix of different salary levels.

The reduced effort proposed here would reduce the Project EAC by about $240k when overheads and escalation are considered, which would increase the contingency fraction reported in August to 15.4%. Given our continued cost difficulties, I will need to be given strong reasons not to take these reductions.

Attachment 1 – Call for Review of AP plans

Subject: AP review
Date: Thu, 10 May 2001 21:49:43 -0500
From: Jim Strait <strait@fnal.gov>
To: Steve Peggs <peggs@bnl.gov>, Fulvia Pilat <pilat@BNL.gov>,
Tanaji Sen <tsen@fnal.gov>, Bill Turner <wcturner@lbl.gov>
CC: Bill Turner <wcturner@lbl.gov>, Erich Willen <willen@bnl.gov>,
Mike Harrison <harrison@bnl.gov>, Jim Kerby <kerby@fnal.gov>,
Jim Strait <strait@fnal.gov>, Bill Barletta <wabarletta@lbl.gov>,
Peter Limon <pjlimon@fnal.gov>, Doug Fisher <fisher@fnal.gov>,
Phil Pfund <pfund@fnal.gov>

Folks,

I would like to conduct a review of the US LHC Accelerator Physics effort planned for the roughly year and a half between now and the end of FY2002. I would like each laboratory to send to me a brief discussion of the work planned for this period with estimates of the effort (FTE-months, or FTE-years, or average FTEs for the period) required for the each piece of work. I would like you to evaluate each piece of work as to how closely it is related to the design and construction of the hardware deliverables of the US LHC Project, to the design and construction of other equipment or systems for the LHC for which we are not directly responsible, or to planning for dealing with operational issues in the LHC. Your discussion need not be long or elaborate, but should be complete enough to clearly describe each line of work that is planned, and be complete enough to form the basis for planning the overall AP program.

I would like your response by Wednesday May 23. If you have any questions, or want to discuss this with me please call or e-mail me.

Cheers,
Jim

BNL, May 22, 2001

Core activities of BNL US-LHC Accelerator Physics through the end of FY2002

DRAFT

Fulvia Pilat, BNL

The following contains the draft plan for Core US-LHC Accelerator Physics work at BNL until the end FY 2002. The plan will be discussed at the US-LHC AP Review planned for June 4th at FNAL.
The Table below summarizes the work plan, with discussion of single line items following. The Table lists areas of activity, possible classification, the average number of FTE's until the end of FY 2002, and the list of people involved in each activity. The "classification" tries to respond to Jim's criteria:

A. Related to the design and construction of US-LHC hardware deliverables
B. Related to the design and construction of other LHC equipment or systems
C. Related to planning for LHC operational issues.

activity	class	Average FTE's	People
Tracking: Magnet reference harmonics Magnet measured harmonics Alignment reference errors Alignment measured errors	A	0.7	Fischer, Ptitsyn
Checking correction strengths	A	0.1	Fischer, Ptitsyn
Data management, exchange	A	0.2	Pilat, Tepikian
TAN luminosity monitor	A	0.2	Drees
Alignment Workshop Preparation, organization, follow-up	A	0.3	Trbojevic Tepikian
Alignment software	A	0.2	Tepikian
LHC Instrumentation	B	0.1	Drees
IR Corrections: Set-up of LHC IR correctors Closed-orbit, feedback at IP	B, C	0.2	Pilat, Ptitsyn
RHIC beam experiments: IR, beam-beam, time-dependent, Luminosity&background	C	0.2	Drees, Fischer Pilat, Ptitsyn Tepikian
Organization	A, C	0.1	Pilat

Discussion of line items.

?? **Tracking**

Tracking is necessary to verify possible changes in magnet reference harmonics (cfr. Recent KEK b6 revision), test machine performance with measured magnet harmonics (as they become available). Likewise, tracking with reference alignment errors and measured alignment tolerances as they become available (end of 2001, cfr. Jim Kerby)

?? **Corrector Strengths**

It is necessary to verify corrector strengths with any changes in reference tables and measured error distributions, to make sure that established criteria on maximum strengths and margins are respected.

?? **Data management**

Data management and exchange among laboratories, database design and interface. We need to address production monitoring and quality assurance.

?? **TAN Absorber and Luminosity monitor**

Collaboration with LBL on developing and testing the TAN equipment, in particular the luminosity monitoring aspects

?? **Alignment Workshop**

Preparation and organization of the Second US-LHC Alignment Workshop, following the 1999 Workshop organized at Fermilab. A good timing is likely beginning of 2001, when the first measurement from the inner triplet assembly will become available 9again, cfr. Jim Kerby). An organizing committee should be set up well in advance to decide about the content of the Workshop and its integration with the CERN alignment program.

?? **Alignment software**

The “tripstat” code for IR RHIC alignment will be adapted to the LHC IR integration and production review.

?? **LHC Instrumentation**

It is possible and desirable for US-LHC AP to contribute to the review and development of LHC instrumentation systems, which includes integration of IR instrumentation.

?? **IR Correction**

BNL-AP will continue working on LHC IR Correctors setting techniques, for which a collaboration with CERN is already established, and for which RHIC is the optimal test bench. We plan also to study IP orbit control and feed-back.

?? **Beam studies at RHIC**

Although not core, beam studies at RHIC are a unique opportunity to studies issues relevant to LHC (IR correction, beam-beam, luminosity monitoring and collimation, time dependent effects, etc.) and even more fundamentally, to establish control room collaboration between US-LHC and CERN Personnel in preparation for the pre-ops and ops in FY 2003 and beyond. It may be desirable to expand the exchange program now, well before FY 2003.

LHC Accelerator Physics Plans from May 2001 to End of 2002
Fermilab

I. Projects related to the IR quadrupoles

- Impact of alignment tolerances on accelerator physics, reference alignment table.
The table was established during a workshop in October '99. This table needs to be updated with measurements on the first prototype and AP studies will be necessary to study the impact of expected misalignments. Work will be in close collaboration with Phil Schlabach, Tom Nicol and Mike Lamm.

- Develop acceptance criteria for the quadrupoles.
These criteria will be developed so that the production quadrupoles meet the requirements of the functional specifications. AP input will be required in field quality and alignment issues. The goal will be to develop a plan for measurements so that as far as possible all production quadrupoles meet the criteria. In cases where magnets fall outside the criteria, AP studies may be required to study the impact on machine performance and suggest ways to minimize harmful effects on the beam, e.g. by magnet sorting. The acceptance criteria will be developed together with Mike Lamm and Phil Schlabach.

- Design of 2nd generation IR quadrupoles using Niobium-Tin.
This study has begun in collaboration with Sasha Zlobin. Initial studies show that larger aperture magnets with the same gradient as in the 1st generation will allow beta* to be lowered and the crossing angle to be increased without loss of physical aperture. Field quality issues with these quadrupoles both in design and tracking remain to be addressed. The goal is to develop a persuasive case that these quadrupoles will allow the ultimate luminosity to be attained – something that is not possible with the 1st generation.

- Sorting strategies with the IR quadrupoles.
As the production begins, there may be a small pool of quadrupoles (three to four) available amongst which local sorting procedures could be applied. The same will be true for the quadrupoles supplied by KEK. AP studies can suggest the right quadrupoles to be paired in Q2a/Q2b and also in the choices for Q1 and Q3.

II. Beam-beam studies – specially strong-strong studies.

In collaboration with Mathias Vogt and Prof Jim Ellison (University of New Mexico) we are developing algorithms to study the dynamics of the beam-beam interactions when both beams have the same intensity. The LHC will be the first such hadron collider. Initial results of these studies will be reported at the beam-beam workshop at Fermilab from June 25-27th, 2001. These studies will continue over the next 18 months and have the potential to make an important contribution in the understanding of beam dynamics in the LHC.

III. Energy Deposition Studies

1. IR1/IR5
- optimization/engineering iterations on the energy deposition protective measures in the IP1/IP5 inner and outer triplets (iterations with TD).
- optimization/engineering iterations on the prompt and residual radiation levels and beam instrumentation in the IP1/IP5 TAS1 and TAN absorbers (iterations with LBNL).

2. Movable collimators in IR6
calculational studies of accidental beam loss in the LHC lattice induced by unsynchronized abort in the IP6 with design of the protective measures (iterations with CERN).

3. IR2/IR8
- Build a MARS calculational model of these regions.
- Perform calculational studies of energy deposition and radiation levels in these regions.

FTEs required

Beam dynamics: 2.0 FTEs
T. Sen: 1.0
M. Xiao: 1.0

Energy Deposition: 1.4 FTEs
I. Rakhno: 1.0
N. Mokhov: 0.25
A. Drozhdin: 0.15

FY2002 AP work at LBNL

- Miguel Furman 0.33 FTE
  - ECE code development – the state of the art code
  - ECE continues to be a crucial issue for LHC operations
  - New data is coming in from many machines – PSR, SPS, APS, PEP II, KEK B
- Bill Turner 0.5 FTE
  - Luminosity monitor development
  - Conceptual work on longitudinal density monitor
  - Write up report on TAN and TAS energy deposition, activation and shielding (with Mokhov and Rakhno input)
  - Finish up lingering work on TAN vacuum chamber impedence and trapped mode issue (withy Derun Li)